AD 700 093

THE TACTICAL, MANUAL METEOROLOGICAL STATION, AN/TMQ 23

Frederick Gralenski

Cambridge Systems, Incorporated
Newton, Massachusetts

December 1968

AFCRL-69-0044

AD700093

THE TACTICAL, MANUAL METEOROLOGICAL STATION, AN/TMQ-23

by

Frederick Gralenski

Cambridge Systems, Inc.

An EG&G Company

50 Hunt Street

Newton, Massachusetts 02158

Contract No. F19628-67-C-0130

Project No. 433L

FINAL REPORT

Period Covered: 31 August 1966 to 31 July 1968

Date of Report: December 1968

CONTRACT MONITOR: Russell M. Peirce, Jr.

Aerospace Instrumentation Laboratory

Distribution of this document is unlimited. It may be released to the Clearinghouse, Department of Commerce, for sale to the general public.

Prepared for

Air Force Cambridge Research Laboratories
Office of Aerospace Research
United States Air Force
Bedford, Massachusetts 01730

38

AFCRL-69-0044

THE TACTICAL, MANUAL METEOROLOGICAL STATION, AN/TMQ-23

by

Frederick Gralenski

Cambridge Systems, Inc.

An EG&G Company

50 Hunt Street

Newton, Massachusetts 02158

Contract No. F19628-67-C-0130

Project No. 433L

FINAL REPORT

Period Covered: 31 August 1966 to 31 July 1968

Date of Report: December 1968

CONTRACT MONITOR: Russell M. Peirce, Jr.

Aerospace Instrumentation Laboratory

Distribution of this document is unlimited. It may be released to the Clearinghouse, Department of Commerce, for sale to the general public.

Prepared for

Air Force Cambridge Research Laboratories
Office of Aerospace Research
United States Air Force
Bedford, Massachusetts 01730

ABSTRACT

The continuing need to obtain surface meteorological measurements initiated the development of the Meteorological Station, Manual AN/TMQ-23, a portable weather station readily conveyed and operated by one observer.

A brief discussion of the technical performance, engineering accuracy and human engineering characteristics of the battery powered, lightweight weather station which contains sensors necessary for the measurement of surface meteorological parameters is presented. The measurable parameters applicable to the meteorological station include dew point/or frost point temperature, ambient air temperature, wind speed and direction and atmospheric pressure. A review of the environmental and field test program is presented.

FOREWORD

The technical data reported in this document was performed in accordance with Contract No. F19628-67-C-0130 sponsored by the Air Force Cambridge Research Laboratories, Office of Aerospace Research, Lawrence G. Hanscom Field, Bedford, Massachusetts.

Program Monitor:	Russell M. Peirce, Jr./CRENA
Reporting Period:	31 August 1966 to 31 July 1968
Date of Report:	December 1968

Meterological Station, Manual AN/TMQ-23 was developed for Air Force applications in meteorology, particularly for the support of meteorological measurements at remote, forward area locations under tactical conditions.

Published for the exchange and stimulation of ideas, the Final Scientific Report does not constitute Air Force sanction of the report's conclusions.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

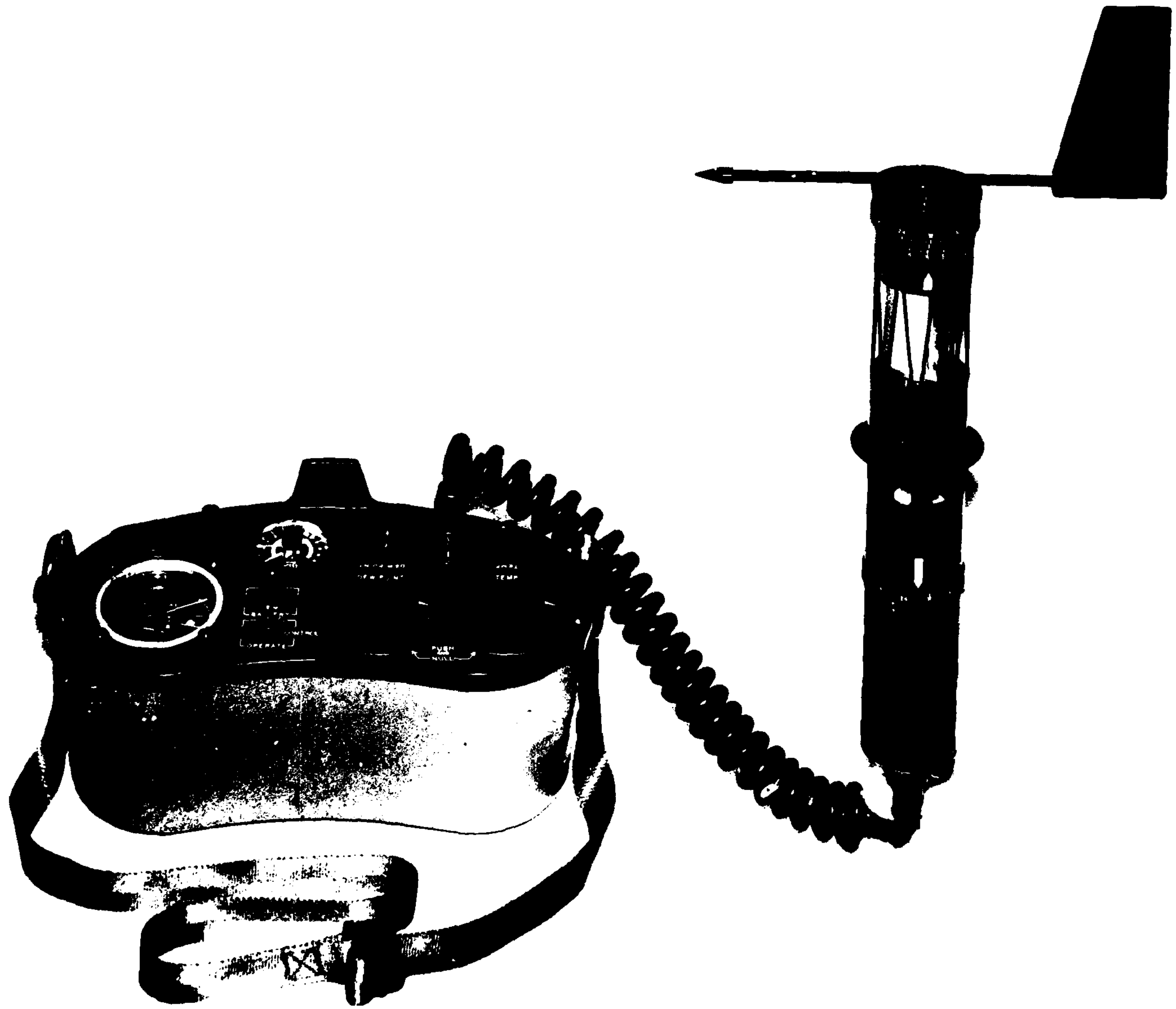

Figure 1. Meteorological Station, Manual AN/TMQ-23

SECTION 1

INTRODUCTION

1.0 GENERAL DESCRIPTION

The meteorologist has always played a significant role in military operations. The increased sophistication of modern weapon systems, the increased maneuverability of troop deployments and the utilization of new tactics have served to further increase the role of the meteorologist. It is necessary to have forward area meteorological parameters throughout all phases of a maneuver. To fulfill this requirement, the field meteorologist must be equipped with instrumentation capable of making accurate measurements of temperature, dew point, wind speed and direction, and barometric pressure. These field instruments must be designed to withstand the rigors of the tactical environment, be lightweight and portable, and operate with a minimum power requirement. The Meteorological Station, Manual AN/TMQ-23 described in this report has been designed to satisfy this need.

1.1 DESIGN GOALS

The basic requirements established at the outset of the development program were that the instrument be capable of being transported and operated by one man, be capable of making a complete and accurate measurement of the basic meteorological parameters, and be capable of operating for prolonged periods over the full environmental range anticipated from common flashlight batteries (BA-30's). With these basic criteria in mind, the following target specification was established and subsequently satisfied by the design effort.

1.2 SPECIFICATIONS

Transmitter	
Weight	2.0 lb.
Size	2.3 in., in dia x 14.5 in., high.
Indicator	
Weight	7.5 lb.
Size	12-1/2 in., long x 5-1/2 in., deep x 5-1/2 in., high.
Pressure	
Range	800 - 1060 mb.
Accuracy	$\pm$ 1.5 mb.
Wind Speed	
Range	2 - 60 KN.
Accuracy	$\pm$ 2 KN (2 - 30 KN), $\pm$ 10% (30 - 60 KN).
Wind Direction	
Range	0 - 360°.
Accuracy	$\pm$ 10° at KN.
Response	5 sec.
Air Temperature	
Range	-60°F to +120°F.
Accuracy	$\pm$ 0.78°F $_{rms}$ (77°F), $\pm$ 1.27°F @ 90% confidence level.
Response	Respond to a 50°F step change to accuracy in one minute.
Dew Point	
Range	-60°F to +120°F.
Accuracy	$\pm$ 0.97°F$_{rms}$ (77°F), $\pm$ 1.6°F @ 90% confidence level.
Response	Respond to a 40°F step change to accuracy in one minute at 77°F.
Power Requirements	Battery Operated, four (4) "D" Cells (BA-30).

SECTION 2

INSTRUMENTATION

2.0 DESCRIPTION OF INSTRUMENT

The Meteorological Station, Manual AN/TMQ-23 is shown in the frontispiece, Figure 1. The station provides wind speed, wind direction, air temperature, dew/frost point temperature and barometric pressure data for use by military forces in operations where weather information is limited or otherwise unattainable.

2.1 INSTRUMENT CONFIGURATION

The station is comprised of a transmitter and an indicator, packed in a carrying and storage case to permit aerial delivery of the station.

2.1.1 Transmitter, Meteorological Data T-1049/TMQ-23

The transmitter is the hand-held portion of the station and contains the sensors to measure wind speed and direction, free air temperature and dew/frost point temperature. The wind direction is measured with a removable wind vane referenced to an internal compass. Wind speed is measured by means of a rotor coupled to a dc generator. The generator, energized by the rotor, puts out a voltage proportional to the wind velocity which is recorded on a wind speed meter located in the indicator unit. Free air temperature and dew point temperature are monitored by a thermistor and a thermoelectrically cooled optical dew point sensor, respectively.

2.1.2 Indicator, Meteorological ID-1605/TMQ-23

The indicator, presented in Figure 2, contains the barometer, the indicators for the ambient air and dew/frost point temperature measurements, the wind speed indicator, a null meter and the necessary controls, electronics and batteries

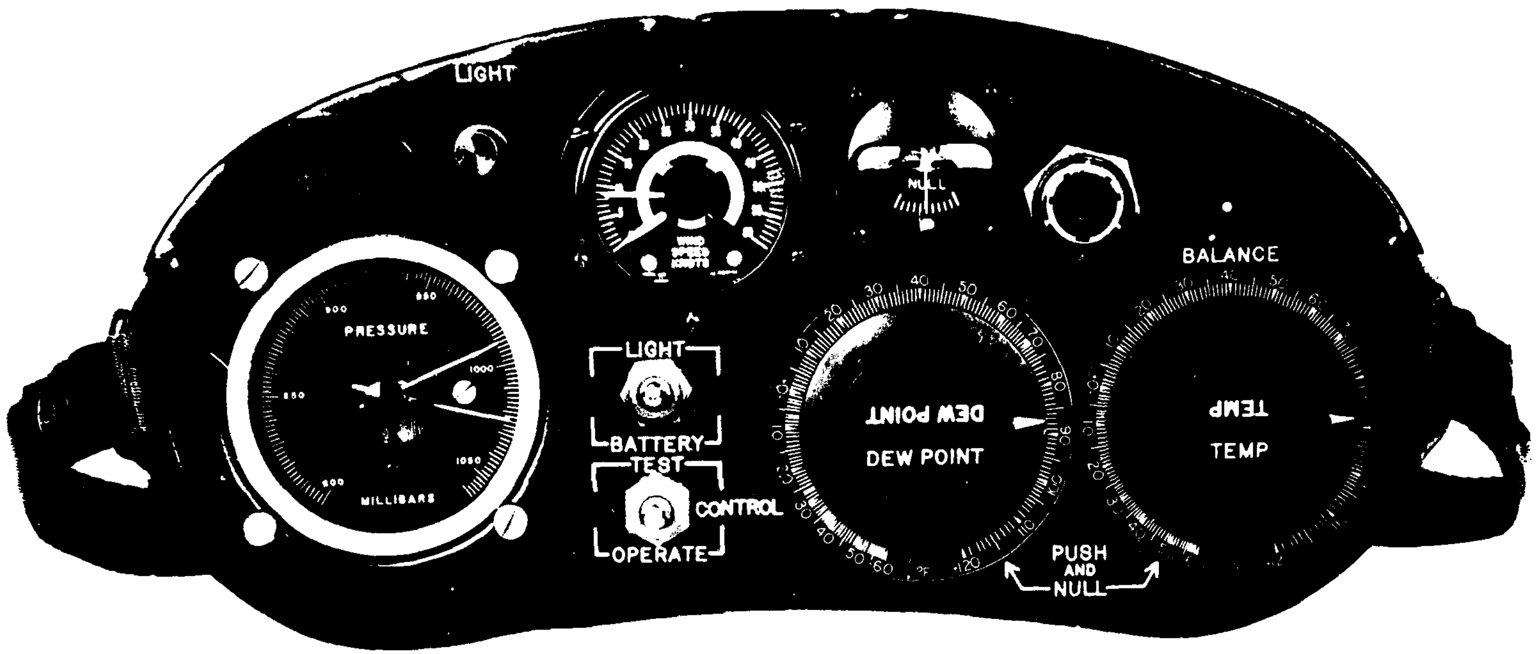

Figure 2. Indicator, Meteorological ID-1605/TMQ-23

associated with the station. The indicator allows the operator to observe and record meteorological data supplied by the transmitter. Electrical connections between the transmitter and the indicator are accomplished by a coiled-cord type cable.

2.1.3 Case, Meterological Equipment CY-6552/TMQ-23

The entire station, along with a spare set of batteries, is packaged in a single carrying and storage case with a polyurethane foam insert for the protection of the equipment. The entire station, packaged for transport, is shown in Figure 3.

2.2 TYPES OF SENSORS EMPLOYED

2.2.1 Wind Speed Sensor

The wind speed sensor chosen for the AN/TMQ-23 is of the Savonius rotor type, indentical to that used in the AN/PMQ-3 hand-held wind measuring set and other similar equipment. This sensor has been proven in the field and is accurate and extremely rugged, affording an enclosed structure which is not susceptible to damage due to rough handling. The rotor, which has a starting speed of less than 2 knots, is mechanically coupled to a miniature dc tachometer, the output of which drives a ruggedized microammeter, calibrated to read wind speed directly from 0 to 60 knots. The meter scale also contains marks for use with the battery voltage check and the dew/frost point system balance calibration. The wind speed meter is provided with an adjustable pointer which can be lined up over the indicating pointer during operation, and thus provide the operator with a semi-permanent record of the wind speed reading.

2.2.2 Wind Direction

Wind direction is determined with a simple wind vane, which is affixed to the top of the transmitter. The wind direction sensor is equipped with a readout

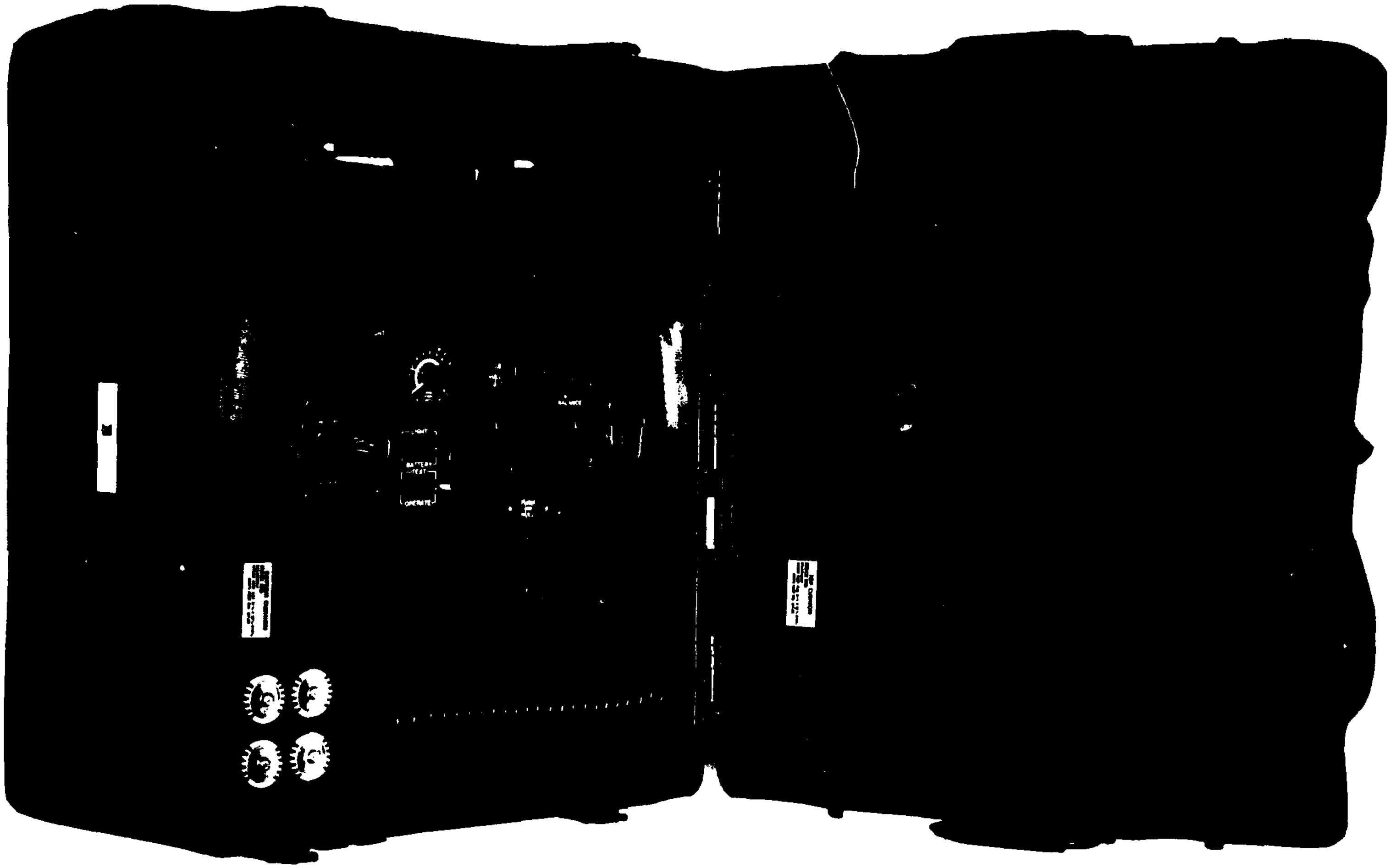

Figure 3. The AN/TMQ-23 packaged for transport

in the form of a 0-360° circular scale. Immediately beneath this scale is located a field-type compass from which magnetic North can be deduced. Approximately two-thirds of the way down the transmitter housing, and just above the operator's thumb position, is a rotatable wind direction indicator wheel which permits the operator to make a semipermanent record of the wind direction reading.

2.2.3 Barometric Pressure

The Barometric pressure is determined with a conventional aneroid barometer covering the range of 800 to 1060 millibars, with overtravel provisions to 200 mb. The actual barometer used is a standard industrial unit, modified to permit the instrument to withstand the severe shock and vibration requirements. The modification consists of removing the instrument from its standard cast aluminum housing and inserting it into a lightweight lexan case to provide a single, pressure-tight housing with a significant reduction in instrument weight. The barometer has an accuracy of $\pm$ 1.5 mb.

2.2.4 Free Air Temperature Sensor

The free air temperature sensor utilized is a miniature thermistor which is mounted on two studs above the dew point sensor, as shown in Figure 4. The thermistor is radiation shielded and is aspirated by an internal dc motor and fan combination located within the transmitter housing. Readout of the free air thermistor is accomplished by a manually balanced Wheatstone bridge, located on the indicator. Depressing the temperature balance knob on the indicator energizes both the aspirator motor and the bridge circuit, thereby permitting the readout operation to be made with one hand. A ruggedized null meter is utilized to balance the bridge circuit. The temperature sensor is calibrated over the range of -60°F to +120°F in 1°F increments, and provides an overall accuracy of $\pm$ 1°F.

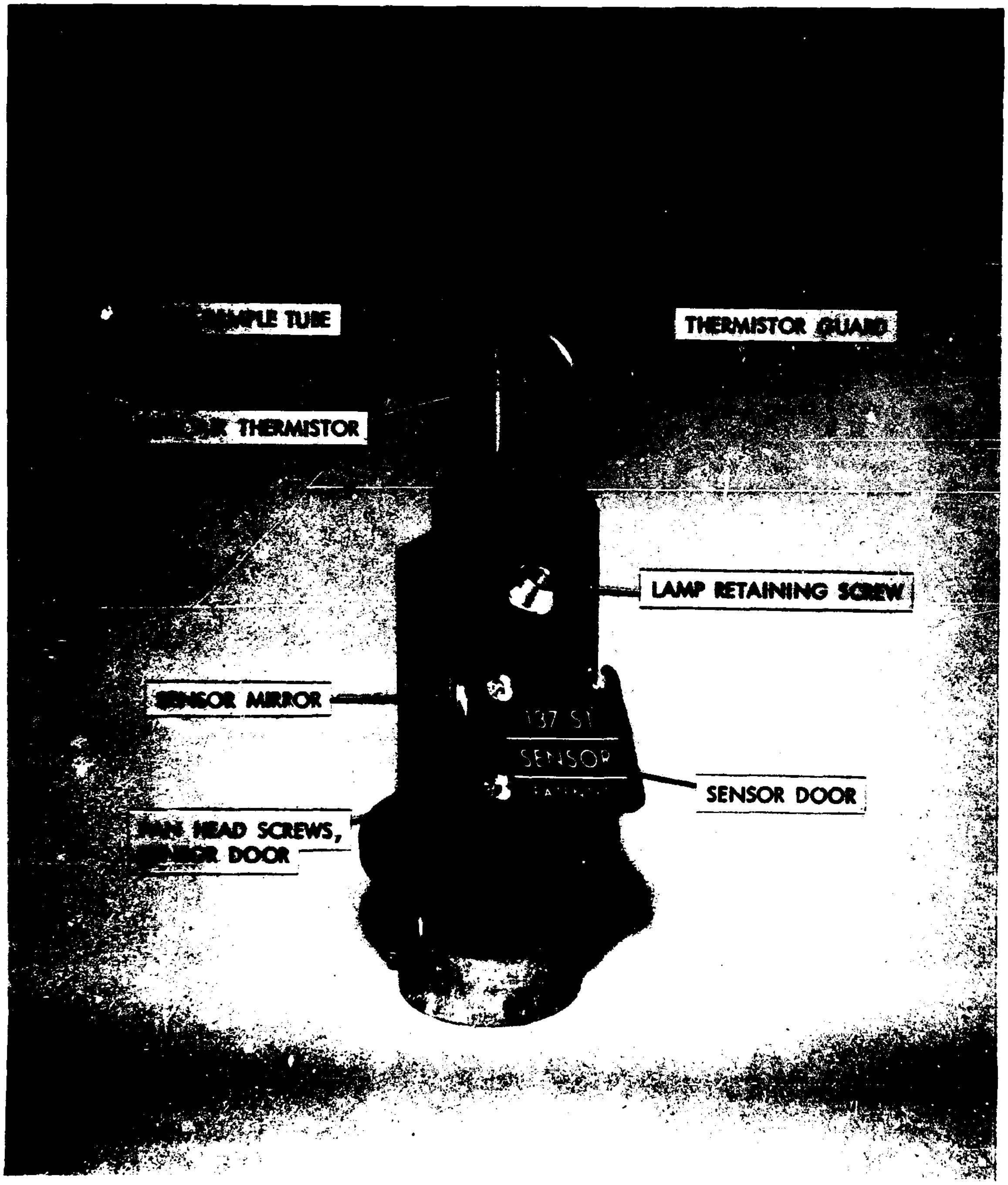

Figure 4. Dew Point and Free Air Temperature Sensors

2.2.5 The Dew Point Sensor

The meteorological station utilizes a miniature, thermoelectrically cooled, optically detected, dew point sensor, of a configuration originally developed for use on the Apollo space program. This sensor, shown in Figures 4 and 5 is located within the transmitter housing and is also aspirated by the dc motor-fan combination. The sensor utilizes a thermoelectrically cooled mirror, the temperature of which is continuously monitored with a miniature thermistor. This mirror is illuminated with a miniature instrument lamp and the reflectivity of the mirror monitored with cadmium sulfide photoresistors. Referring to the block diagram in Figure 6, it can be seen that when the surface of the mirror is free of dew or frost the output of the optical sensing network drives the Inverter/Amplifier circuit which sends current to the thermoelectric cooling module. The cooling module is thermally bonded to the mirror. The cooling process continues until a layer of dew is formed on the mirror, at which time the output from the optical sensing network is reduced, causing the Inverter/Amplifier to reduce the cooling current. This servoloop has true proportional control characteristics, and the system adjusts itself to a point which maintains a fixed dew layer in equilibrium with the water vapor of the air sample. In other words, it adjusts itself to the dew point. The temperature of the mirror, which is the dew point, is read out by a miniature thermistor thermally bonded to the mirror. The dew point sensor is electrically read out in the same fashion as the free air temperature sensor. A separate Wheatstone bridge circuit and null balance knob is provided for the dew point control. Both temperature and dew point balance knobs, when released, automatically deenergize their respective circuits, and remain in a locked position, thereby providing a semipermanent record of the variables. The dew point sensor is capable of measurements between $-60^{\circ}F$ and $+120^{\circ}F$ with an accuracy of $\pm 1^{\circ}F$.

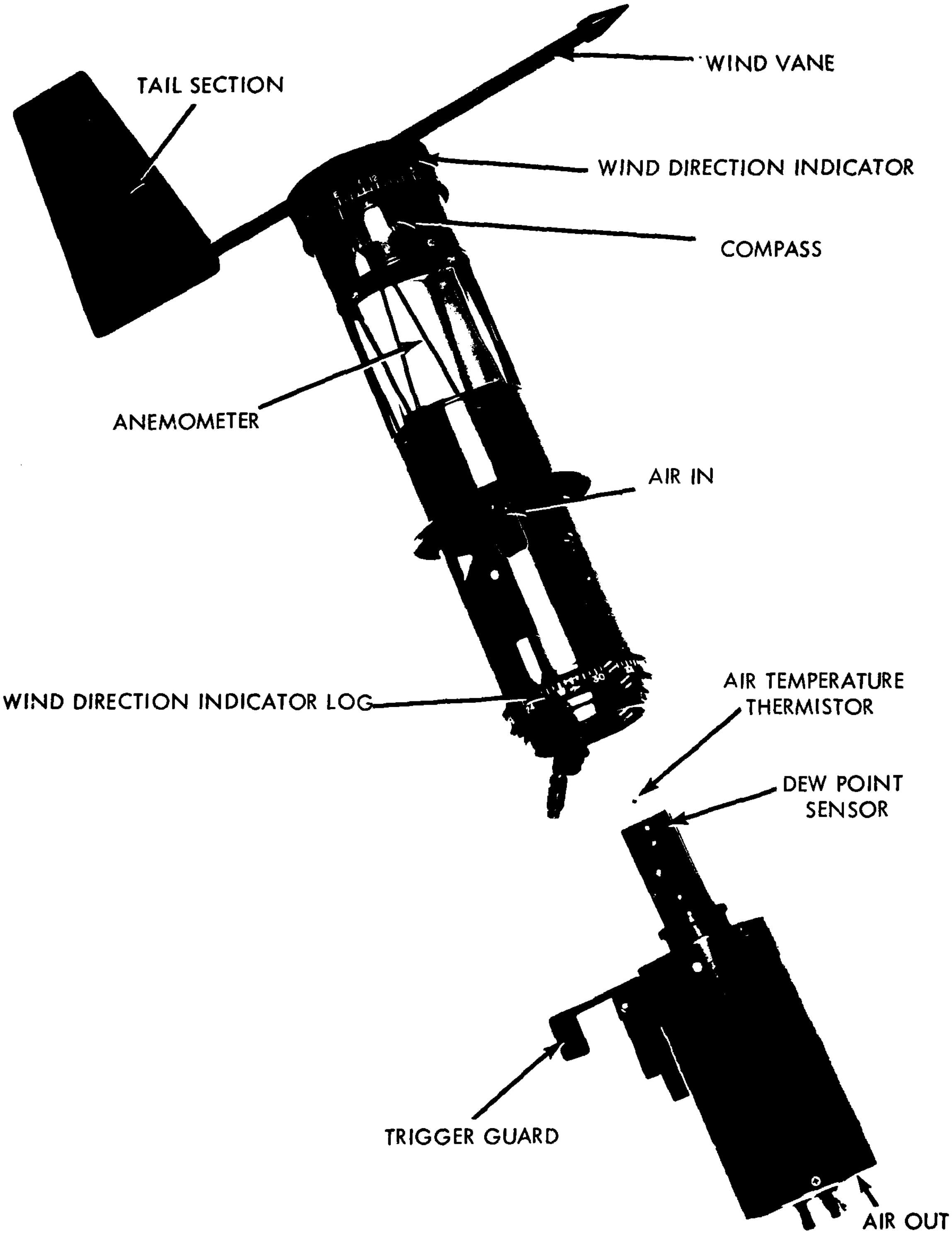

Figure 5. Transmitter, Meteorological Data T-1049/TMQ-23

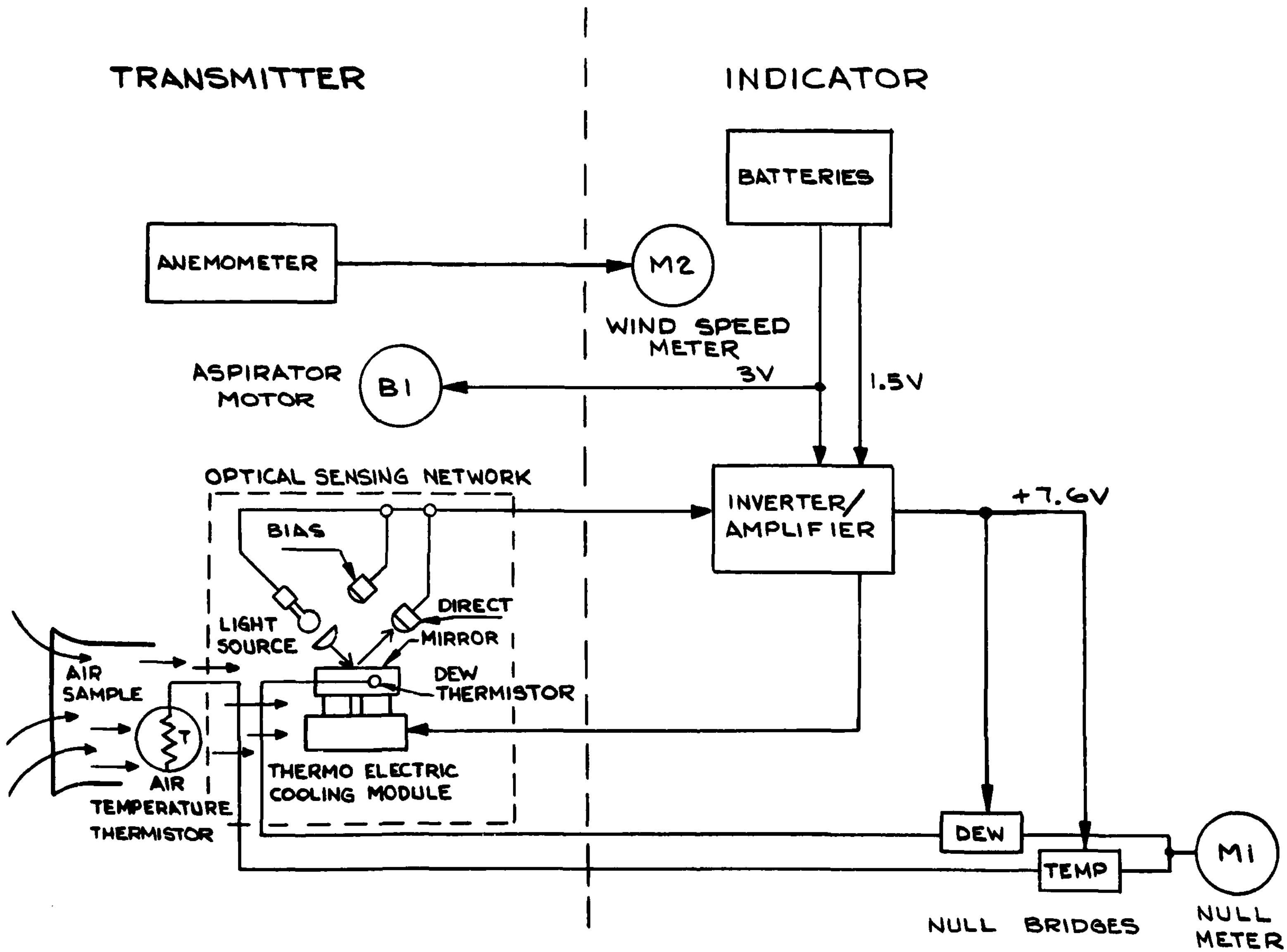

Figure 6. AN/TMQ-23 block diagram.

2.3 UTILIZATION/DEPLOYMENT PROCEDURES

The AN/TMQ-23 is intended for deployment by one man in the field under adverse conditions. The entire unit can be delivered to the observation site by paradrop if desired. The indicator is designed to hang, sling-fashion, over the shoulder of the observer, such that all controls can be operated with one hand. The transmitter, weighing approximately two pounds, is held into the prevailing wind with the other hand. The transmitter is provided with a trigger switch which allows the operator to energize the aspirator motor while taking his wind readings so that, when the temperature and dew point measurements are taken, the respective sensors have had sufficient aspiration to insure that they are seeing a representative sample of the outside air. The entire instrument can be unpacked, deployed and all measurements taken in less than five minutes.

SECTION 3

ANALYSES

3.0 TEST PROGRAM

The AN/TMQ-23 was submitted to Associated Testing Laboratories, Inc., a professional environmental test laboratory, to ascertain that the functional capabilities of the instrument were not impaired following exposure to temperature, humidity and vibrational extremes.

Calibration procedures were performed in accordance with military specifications (MIL-Q-9858) and all instrumentation standards were calibrated utilizing standards not used during the actual test performance. In general, the latter standards have an accuracy equal to ten times that of the working standard. Although the environmental results are documented in Appendix A in their entirety, the following paragraphs present a brief synopsis of the combined documentation.

3.1 TEMPERATURE TESTS

Procedural tests prepared by the engineering staff of this company were submitted to the commercial testing laboratory, where initial equipment tests involved temperature extremes ranging from -80°F to +160°F with the instrument operating between -56°F to +120°F.

The instrumentation was subjected to the temperature test at an initial temperature of +77°F, increased to a peak temperature of +160°F and then decreased to a low temperature of -80°F. Following prolonged exposure to the temperature extremes, operational and visual examinations were made. The system performed satisfactorily throughout the temperature testing.

3.2 MOISTURE TESTS

In order to expedite the development program on this equipment it was necessary to fabricate a temporary interconnection cable between the transmitter

and indicator, due to late delivery of the special environmentally qualified cable required by the instrument. Unfortunately, failure to pot one of the connectors on the prototype cable resulted in water entering the connector, causing a failure during the moisture resistance test. Once corrected, the instrument passed the moisture resistance test without further electrical failures.

Another difficulty experienced during the moisture resistance test was the leakage of moisture into the barometer and wind speed meter. It was found that the set point indicators on both of these units were not tight. It was thus necessary to introduce a design modification which involved the addition of an O-ring seal at the point where the adjustment knob passes through the window of the instrument. After introducing this seal, the problem was alleviated.

The luminescent material utilized to fill the indicator panel engravings deteriorated during extreme humidity conditions. It was necessary to add a protective layer of clear epoxy to the indicator panel to eliminate this problem. After all the above corrections were applied, the instrument successfully passed the moisture resistance test.

During tests on the anemometer, the mechanical coupling located between the rotor and generator failed and it was necessary to re-design this coupling to reflect a more rugged assembly. The anemometer was re-tested successfully.

It should be noted that the environmental tests were performed primarily as an evaluation of the instrument's performance capabilities during extreme climatic conditions and not for the purposes of ascertaining instrumental accuracy under these conditions. Instrumental accuracy tests are to be performed under a separate program conducted by the United States Air Force.

SECTION 4

CONCLUSIONS AND RECOMMENDATIONS

4.0 FINDINGS

The program objective was to design a portable meteorological station that would provide accurate surface weather measurements at remote locations where the instrumentation could be deployed by one observer. This objective was accomplished with the design of the AN/TMQ-23. The following improvements however are recommended should production models of the instrument ever be procured.

1. The present transport case does not make efficient use of the foam insert. A revision should consider the possibility of a plastic exterior, which should result in a more compact and lightweight equipment case.

2. The transport case insert should be of a closed cell foam which would prevent absorption of water in the event that the material was exposed to rain.

3. The cable used to connect the transmitter and the indicator should be modified for observations at low temperatures. Considerable delay was experienced in acquiring the desired cable from the vendor, coupled with a substantial minimum fee. As a result, the proper low temperature cable was not included in the prototype.

4. The indicator case is removable by loosening the retained hardware at the base of the instrument. It is felt that the number of retaining screws should be reduced by one-half, thereby increasing the available space for positioning the components and, at the same time, facilitating battery changes.

APPENDIX A

Test Report No. NT-5108-11 No. of Pages 12

Report of Test on

TACTICAL MANUAL METEOROLOGICAL STATION

Environmental Tests

for

Cambridge Systems, Inc.

Associated Testing Laboratories, Inc.

Burlington, Massachusetts

Date April 2, 1968

	Prepared	Checked	Approved
By	J. Cunningham	M. Pelissier	T. Jarek
Signed	J. Cunningham	M. Pelissier	T. Jarek
Date	4-3-68	4-5-68	4-5-68

Administrative Data

1.0 Purpose of Test:

To verify the physical integrity of the submitted Tactical Manual Meteorological Station through Environmental Testing.

2.0 Manufacturer: Cambridge Systems, Inc.
50 Hunt Street
Newton, Massachusetts

3.0 Manufacturer's Type or Model No.: Model 160

4.0 Drawing, Specification or Exhibit: Associated Testing Laboratories, Inc. Proposal MN-12-293, and written instructions from Cambridge Systems, Inc.

5.0 Quantity of Items Tested: One (1)

6.0 Security Classification of Items: Unclassified

7.0 Date Test Completed: March 6, 1968

8.0 Test Conducted By: **Associated Testing Laboratories, Inc.**
NEW ENGLAND DIVISION

9.0 Disposition of Specimens: Returned to Cambridge Systems, Inc.

10.0 Abstract:

The submitted Tactical Manual Meteorological Station was subjected to a Temperature Test, Moisture Resistance Test, and a Shock Test in accordance with written instructions from Cambridge Systems, Inc. The System was subjected to temperature extremes ranging from -80°F to +160°F. The System was operated at temperature extremes ranging from -56°F to +120°F. The System was subjected to a ten day Moisture

10.0 Abstract (continued)

Resistance Test with temperatures ranging from +68°F to +150°F. The relative humidity within the test Chamber throughout the ten day Moisture Resistance Test was maintained between 90 and 98%. The System, in its shipping case, was subjected to eight shock drops. The System was allowed to free fall drop from the height of 4 feet onto a two inch fir platform.

During and following completion of each Test, the Tactical Manual Meteorological Station was functionally operated. The System functioned properly during and following completion of each test, with the exception that following the first day of Humidity, it was noted that the System malfunctioned. Malfunction was due to a faulty cable. The cable was changed and the System then operated properly. The System was visually examined for evidence of physical damage following completion of each test and with the exception of some minor corrosion due to Humidity, none was observed.

It was noted, however, that the Shipping Case incurred some damage due to the Shock Test.

Following completion of the entire Test Program, the Tactical Manual Meteorological Station was returned to Cambridge Systems, Inc. for further evaluation.

CALIBRATION AND STANDARDIZATION

Each laboratory division maintains a Calibration and Instrumentation Department with control over the wide range of electronic, mechanical and environmental test equipment in inventory at the facilities. The calibration procedures are based on the requirements of Specification MIL-Q-9858. All working instruments in the laboratory are periodically calibrated by means of calibration standards which are not used in the performance of tests. These calibration standards are maintained in a calibration and instrumentation area. Further, the calibration standards are periodically calibrated by either their manufacturers or by an approved outside source.

When the calibration standards are re-calibrated, a certification is obtained which not only details the standards' accuracy but also specifies that the calibration of the equipment is traceable in an unbroken line to the National Bureau of Standards. These certifications, as well as the individual equipment history cards, are on file at each laboratory division. In addition, a "calibration due" sticker is placed in a prominent position on each item of equipment. It is incumbent upon each test operator to examine the sticker before using any equipment to insure that the equipment will not be due for calibration during the test period.

In general, the laboratory standards used for the calibration of the working test equipment will have an accuracy equal to or greater than ten times that of the working standard. Typical calibration frequencies for test equipment are as follows:

Item	Calibration Period
1. Galvanometer Type Laboratory Quality Meters.	six months
2. Vacuum Tube Voltmeters	one month
3. Impedance Bridges	yearly
4. Electronic Counters	six months

CALIBRATION AND STANDARDIZATION

Item	Calibration Period
5. Oscilloscope Preamplifiers	three months
6. Vibration Systems	three months (with spot calibration prior to use)
7. Signal Generators	three months
8. High and Low Temperature Chambers	two months
9. Multi-testers	three months
10. Pressure Gauges	six months
11. Calibration Standards	yearly
12. Shock Machines	six months
13. Recording Instruments	Prior to Use.
14. Precision Scales and Balances	three months
15. Special Purpose Test Equipments	three months Uunless otherwise specified)

LIST OF APPARATUS

Item	Manufacturer	Model No.	Accuracy	Calibration Date	Calibration Date Due
Temperature-Altitude Chamber	Associated Testing Laboratories, Inc. (Mfg. Div.)	LHA-27-CR-LC	±2°F	1-22-68	3-22-68
DC Power Supply	Trygon Electronics Inc.	M60-5A		9-14-67	3-14-68
Digital Voltmeter	Non-Linear Systems, Inc.	64	±0.25%	2-27-68	3-27-68
Amplifier	Dymec Corp.	2411A	±0.007%	2-26-68	5-26-68
DC Power Supply	Opad Electric	RS20	±3%	1-30-68	5-1-68
Multimeter	AVO, Ltd.	8-Mark II	AC-±2.25%F.S. DCV-±2%F.S. DCI-±1%F.S.	1-13-68	4-13-68
High-Low Temperature Humidity Chamber	Associated Testing Laboratories, Inc. (Mfg. Div.)	LHH-36-LC	±2°F	1-30-68	3-30-68

TEMPERATURE TEST

TEST PROCEDURE

The submitted Tactical Manual Meteorological Station was subjected to a Temperature Test in accordance with written instructions from Cambridge Systems, Inc. The following is a description of the test as it was performed.

The Tactical Manual Meteorological Station was installed within a High Low Temperature Chamber as shown in Figure 1 below:

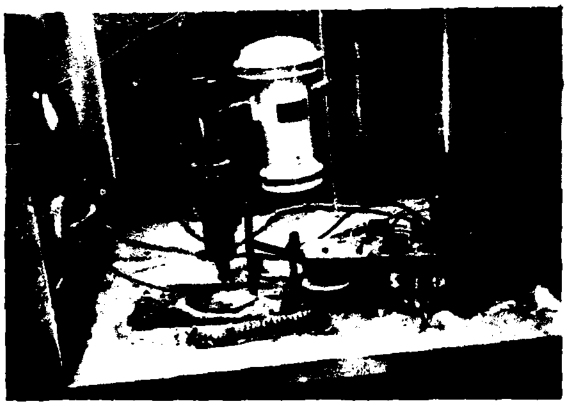

Figure 1

The System was subjected to a 14 Step Test which is described as follows:

Step 1 - System installed in Chamber and stabilized at +77°F.

Step 2 - System functionally checked by an Engineering Representative of Cambridge Systems, Inc.

TEMPERATURE TEST

TEST PROCEDURE (continued)

Step 3 - Temperature within Test Chamber raised to +160°F and maintained for 24 hours.

Step 4 - Temperature decreased from +160°F to +115°F and maintained for 1/2 hour.

Step 5 - System functionally operated by Engineering Representative of Cambridge Systems, Inc.

Step 6 - Temperature within Chamber reduced from +120°F to +77°F and maintained for 2 hours.

Step 7 - System operated by Engineering Representative of Associated Testing Laboratories, Inc.

Step 8 - Temperature within Chamber reduced to -80°F and maintained for 24 hours.

Step 9 - Temperature within Chamber raised from -80°F to -56°F and maintained for 2 hours.

Step 10 - System functionally operated by Engineering Representative of Cambridge Systems, Inc.

Step 11 - Increase temperature from -56°F to -20°F and maintain for 2 hours.

Step 12 - System functionally operated by Engineering Representative of Cambridge Systems, Inc.

Step 13 - Increase temperature from -20°F to +77°F and maintain for 2 hours.

Step 14 - System functionally operated by Engineering Representative of Associated Testing Laboratories, Inc.

NOTE: Temperature changes were made as rapidly as possible.

Following completion of each Step of the Temperature Test, the Tactical Manual Meteorological Station was visually examined for evidence of physical damage or deterioration.

TEMPERATURE TEST

TEST RESULTS

There was no evidence of physical damage or deterioration as a result of the Temperature Test. The System functioned properly when operated throughout the Temperature Test.

All data pertaining to operation of the System was recorded and retained by an Engineering Representative of Cambridge Systems, Inc.

MOISTURE RESISTANCE

TEST PROCEDURE

The Tactical Manual Meteorological Station was subjected to a Moisture Resistance Test in accordance with written instructions from Cambridge Systems, Inc. The following is a description of the test as it was performed.

The System was installed within a High Low Temperature Humidity Chamber with all connections necessary for operation of the System coming through a port in the Chamber wall. The System was subjected to a 24 hour drying period at +130°F. Following the 24 hour period, the temperature within the Chamber was reduced to +77°F and maintained for an additional 24 hours. Following the 24 hour period at +77°F, the System was functionally operated by an Engineering Representative of Associated Testing Laboratories, Inc. The System was then subjected to five 48 hour humidity cycles in accordance with Military Standard MIL-STD-170(Sig C). The temperature within the Chamber was linearally raised from room temperature to 150°F in a 4 hour period. The temperature of 150°F was maintained for 8 hours, following which the temperature was linearally decreased from 150°F to 80°F in 4 hours.

Following completion of each 24 hour portion of the cycle and while at +80°F, the System was functionally operated. Following completion of the entire 12 day Humidity Test, the Tactical Manual Meteorological Station was visually examined for evidence of physical damage or deterioration.

TEST RESULTS

It was noted on the first functional check at Humidity Conditions that the System would not operate properly due to a faulty Connector Cable. The Cable was changed and the Unit functioned properly. Following completion of the second day at Moisture Conditions, it was noted that the System did not function properly due to water accumulating under the glass of the Pressure Gauge and Wind Gauge. The collected moisture was blown away and the Unit functioned properly. Following the third day, it was noted that water had again collected but the Unit functioned properly.

MOISTURE RESISTANCE

TEST RESULTS (continued)

On examination, following completion of the Test, the only evidence of deterioration was some slight amount of corrosion on the Null Gauge inside the Case. Except where indicated, the System functioned properly throughout the Test.

All data pertaining to operation of the System was recorded and retained by an Engineering Representative of Cambridge Systems, Inc.

SHOCK DROP TEST

TEST PROCEDURE

The submitted Tactical Manual Meteorological Station was subjected to a Shock Drop Test in accordance with written instructions from Cambridge Systems, Inc. The following is a description of the test as it was performed.

The System, prepared for transient in its Shipping Case, was subjected to a Shock Drop Test. The System was dropped from a height of four feet onto a two inch fir floor. The System was subjected to a total of eight drops, which were made on the Case Faces, Edges, and Corners as follows:

Drop Number	Drop Location
1	Top
2	Bottom
3	Side
4	Top Edge (Front)
5	Bottom Edge (Rear)
6	Side Edge (Right Top)
7	Top Corner (Front Left)
8	Bottom Corner (Rear Right)

Following each drop, the System was visually examined for evidence of physical damage or deterioration. The System was examined for damage that would have an adverse effect on the operation of the System. The System was visually inspected inside and out, following which the Batteries were installed and the System was functionally checked.

TEST RESULTS

On examination, following the last three Shock Drops, it was noted that the Case had incurred some small dents at the point of impact. There was no further evidence of physical damage or deterioration as a result of the Shock Drop Test.

SHOCK DROP TEST

TEST RESULTS (continued)

The Unit functioned properly, where required, throughout the Shock Drop Test. All Data pertaining to operation of the Unit was recorded and retained by an Engineering Representative of Cambridge Systems, Inc.

Following completion of this test, the submitted Tactical Manual Meteorological Station was returned to Cambridge Systems, Inc. for further evaluation.

Unclassified

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* Cambridge Systems Operation, EG&G, Inc. 50 Hunt Street Newton, Massachusetts 02158	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

THE TACTICAL, MANUAL METEOROLOGICAL STATION: AN/TMQ-23

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

Scientific. Final. 31 August 1966 - 31 July 1968 Approved: 18 Feb. 1969

5. AUTHOR(S) *(Last name, first name, initial)*

Gralenski, Frederick

6. REPORT DATE December 1968	7a. TOTAL NO. OF PAGES 30	7b. NO. OF REFS

8a. CONTRACT OR GRANT NO. F19628-67-C-0130 b. PROJECT NO. 433L c. TASK No. N/A d. DoD Element 75668014 DoD Subelement N/A	9a. ORIGINATOR'S REPORT NUMBER(S) 9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)* AFCRL-69-0044

10. AVAILABILITY/LIMITATION NOTICES

1- Distribution of this document is unlimited. It may be released to the Clearinghouse, Department of Commerce, for sale to the general public.

11. SUPPLEMENTARY NOTES TECH, OTHER	12. SPONSORING MILITARY ACTIVITY Air Force Cambridge Research Laboratories (CRE) L. G. Hanscom Field Bedford, Massachusetts 01730

13. ABSTRACT

The continuing need to obtain surface meteorological measurements initiated the development of the Meteorological Station, Manual AN/TMQ-23, a portable weather station readily conveyed and operated by one observer.

A brief discussion of the technical performance, engineering accuracy and human engineering characteristics of the battery powered, lightweight weather station which contains sensors necessary for the measurement of surface meteorological parameters is presented. The measurable parameters applicable to the meteorological station include dew point/or frost point temperature ambient air temperature, wind speed and direction and atmospheric pressure. A review of the environmental and field test program is presented.

DD FORM 1 JAN 64 1473

Unclassified

Security Classification

Unclassified

Security Classification

14. KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
Hygrometers						
Anemometers						
Dew Point Measurement						
Frost Point Measurement						
Meteorology						
Meteorological Surface Measurements						

INSTRUCTIONS

1. ORIGINATING ACTIVITY: Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization *(corporate author)* issuing the report.

2a. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2b. GROUP: Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. REPORT DATE: Enter the date of the report as day, month, year, or month, year. If more than one date appears on the report, use date of publication.

7a. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. NUMBER OF REFERENCES: Enter the total number of references cited in the report.

8a. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.

8b, 8c, & 8d. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9a. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9b. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers *(either by the originator or by the sponsor)*, also enter this number(s).

10. AVAILABILITY/LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

(1) "Qualified requesters may obtain copies of this report from DDC."

(2) "Foreign announcement and dissemination of this report by DDC is not authorized."

(3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through
________________."

(4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through
________________."

(5) "All distribution of this report is controlled. Qualified DDC users shall request through
________________."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring *(paying for)* the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as *(TS), (S), (C), or (U)*.

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.

Unclassified

Security Classification